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AN
INTRODUCTORY LECTURE,

DELIVERED BEFORE THE

INSTITUTE OF ARTS AND SCIENCES,

PITTSBURGH,

On the 20th December, 1836.

BY THE REV. R. BRUCE, D. D.

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INTRODUCTORY LECTURE.

GENTLEMEN:—There are principally three things which make a city prosperous; advantage of situation, commerce, and manufactures. Peculiar states of society may nourish a town into great splendor independent of these; but these are the permanent parents of prosperity, which never fail of success. Ancient Rome grew great by conquering the nations of the world, and carrying home the spoils of the conquered. Becoming the head of an immense empire which she governed by the terror of her eagles, she swelled at length into a gigantic stature, and maintained it for a few centuries; but her growth was not the natural effect of those laws which advance a particular place to eminence by its fostering others, and by being reciprocally beloved and fed by them. Hence, when the nations of Europe recovered the management of their own affairs, Rome became covered with the ruins of her own greatness; and though the human family was never so rich in arts and enterprises of every kind as now, yet she sits solitary and decrepit with age.

In a very early period of human society, Tyre was the most advantageously situated, and her inhabitants became princes. They had commerce and manufactures; and by means of these, though inhabiting a desert spot, they outstripped in genius and enterprise all other people. From them sprang the germ of all subsequent improvements. They filled the Mediterranean with that commerce which being furnished to them from all regions of the east, civilized and stimulated to exer-

tion the nations on the north of Africa, the west of Europe, and in the islands of Greece.

That small spot, now a place for the nets of fishermen, sent her workmen to Solomon, on the one hand, for every refinement in the useful arts, and her mariners to the British seas, on the other, to smelt from their ores the iron, tin, lead, and copper of which she herself and the nations which she was polishing and enriching stood in need. But as times altered and the wants of refined society increased, expenses must be saved; and the carriage from India or Persia of goods by caravans must be avoided. Alexander the Great, whose mind as a statesman was equal to his genius as a warrior, espied the site of Alexandria, in Egypt. In the state of the world, as then known, no spot presented so many advantages. A canal connected it with the Red Sea, and it was connected itself with the whole of the Mediterranean and the Western ocean. How did Alexandria flourish? She rose in population next to Rome herself; and while Rome can boast of Cicero as an orator, and Virgil and Horace as poets, Alexandria numbers far more men of learning and scholars of the arts. It was Alexandria which sent Eratosthenes to measure the length of a degree, to know the bulk of our earth; it was this city that gave birth to the greatest female mathematician the world ever saw; and it was from it that the great Ptolomy arose, who, upon the most absurd of theories, explained the whole movements of the heavenly bodies, and enriched the science of mechanics by those talents of address, which he brought into operation, to surmount triumphantly the inconsistencies of his theory. And it was in ancient Alexandria, two thousand years ago, that the first experiments were made on the power of steam. These experiments to be sure were like the conic sections of Papus, another of her citizens, admired only, and not reduced to practice. Papus' conics were intellectual beauties, by the study of which philosophers improved their minds, till Kepler's discovery of the elliptical orbits of the planets; and then the theorems of Pa-

pus were applied, as the sublime principles, which explained the phenomena of our solar system. So though they saw the expansive power of steam, the age in which they lived, and the place of the world they inhabited, made few demands for its immediate application; and their ingenious machine, which wrought by water turned to air, became forgotten.

After the discovery of the passage round the Cape of Good Hope, Alexandria must fall from her station as the first commercial city of the world; and she fell from this state never to rise to it again, though she may spring up as a branch of the manufactures and commerce of the world. The voyage around the south of Africa, and the discovery of America, have settled two great points; that we shall never have one great capital standing by conquest, nor one concentrating the trade of the civilized world. The nations may have some broils and even protracted warfare; but the great current of human energy will forever flow, little retarded or disturbed, in the cultivation of the arts of life, by preparing materials for comfort or luxury and transferring them to the places where they are demanded. The ocean being open to all after the discoveries mentioned, every nation of Europe sent forth its adventurers; and emulating one another, the people whose resources at home assisted them most to outstrip their competitors, were found to be ultimately the most successful. Portugal laid hold upon many countries, Spain claimed almost all the new continent, France picked up rich spots; but after the commerce of Portugal in spices, and of Spain in gold, had settled into a uniformity or fallen off, the civilization and refinements of age after age called for new and still more splendid fabrics of manufactures, and Portugal found herself destitute of the means of a successful competition, and Spain, though she had some of the finest materials, yet had not sufficient power to improve them. These nations, on a comparison of national improvement, are now therefore poor and destitute. Even France must satisfy herself with the flowers and roses of

national manufactures and commerce. It is Great Britain, which, in Europe, has left all other people at almost an invisible distance behind. What is the cause of this? superiority of climate? superior bodily strength? greater power of genius? brisker application, and sterner perseverance? Not at all. When the competition among the nations of Europe began after the voyages of Vasco De Gama and Columbus, the Spaniards and Portuguese excelled in enterprise and energy of body and mind almost all others. What then has assigned the palm so eminently to Britain? Two things, and nothing else. Her mines of useful metals are inexhaustible and her coal lies along side of her ores, not only to smelt them, but to turn the pure metals into every form of art, and to propel the mightiest fabrics of machinery. Steam power is not primitive; it presupposes fuel, and where this is not abundant, it cannot be maintained. Steam must now be considered the sole agent in national prosperity, and where it cannot be generated in exhaustless exuberance the people must necessarily become inferior. The consumption of coal in Britain in the form of fires, furnaces, and for the movement of machinery of every kind, is immense. She has fuel, however, which, at her present consumption, will serve for twenty-five thousand years to come. They are these riches which nature has laid up, that make the British empire stand as a great cabinet of useful arts and materials for much of the civilized world. For in Europe, while formerly many nations were far in advance of her in almost every art, yet she is now the mistress of the land and of the sea among them, in a meaning of the term very different from martial strife,—by leading commerce, and by shewing that she has the springs of strength in her bosom which none of them can reach or emulate.

These observations have been made to throw some light, by comparison, on the situation of our own city. Our city stands related to a greater population, springing up towards the west of us, than ever ancient Tyre visited, in what, she said, lay to-

wards the setting sun; we will have more canals connected with us than ran towards Alexandria; and nature has done even more for us, in the riches of our mines, than she ever did for any other spot of the earth. There have been many towns situated to receive any extent of commerce; with the most capacious harbors, and the most enterprising navigators, but their resources were limited by being situated on islands, or isthmuses, or small regions of the earth. Great as Britain's power and wealth are, she herself is but a speck on the map of the globe. Her prosperity, though now the weightiest of all, is destined to suffer an eclipse. Tyre, from her situation, was once the mart of the nations, but the increase of mankind, the progress of civilization, and the rising energies of the regions to the west of her, transferred her glory to Alexandria; this city communicated hers to various people, Genoa, and Venice, and others, still farther west, until they have pitched their tent in the British isles; but this is not their home, there are regions still farther west; which, from their very features, must be the ultimate lap of repose for arts and merchandize. The people who have sat down in America can never adopt any thing of the deadening and heartless policy of the Chinese. Enterprise, unlimited as is the genius of their freedom, is already among them; and it would be a contradiction to the fact that the human family is progressive, to suppose that their character is not to be maintained. The wide spread regions towards the west of them, fertile beyond any other portion of equal extent which our earth affords, will make New York, Philadelphia, Baltimore, and Charleston, far more populous and great, than the limited extent of the British isles will ever permit their renowned cities to become. But New York, the greatest of these, and justly the proudest of her harbor, has but one channel of a promise from nature of her unlimited greatness. We, in the last repose of the improvements of mankind, have two, most wonderfully co-operating, and showing us that our calculations can never be too sanguine, and

can never be made on a deceitful foundation. Our water communications ramify through an unmeasurable extent of the prime soil of our continent, and while the mountains and hills in our adjoining regions are full of the richest mines of ore, our city occupies the very centre of a coal field to which none other bears a comparison. It is a beautiful remark of a celebrated writer respecting coal, that while its origin is uncertain and disputed, the final cause or reason for which infinite wisdom laid it up in such immense storehouses is not doubtful: It was obviously, says he, laid up for the use of man. The spirit of this remark cannot be perceived till we reflect a little. Not surely for the use of man when leading a savage life, or tuning the shepherd's reed, or even when satisfying himself with the simplicity of husbandry. It was laid up for enterprises such as the world now sees; and this truth appears from the very situations in which it is generally found. It is indeed found in some very distant regions, as in Melville island, and in Spitzbergen; but while these may be reservoirs for future ages, it is a fact that where it most abounds are situations of fertility to support a dense population, and bordering on points inviting to extended commerce. The coal fields of all the British empire are of this description, and those of our country are the same. What, then, is the conclusion respecting our own situation? That the very voice of nature herself is calling us to a duty of industry and enterprise; of industry in all that fire, furnace, and force of steam can accomplish, and of enterprise to every place to which our waters can carry us.

While nature has done so much for our country, and the genius of our population has a bearing so promising, and our civil privileges are so elevated; yet, for a time, it is possible that the community may not reap the full fruits of the age in which they live, and of the situation in which they are placed. Ignorance may put her finger among the wheels of the machine to be moved, and then its operation will be heavy and comparatively unproductive. It would be presumption, where so

many successful manufactures are carried on, not to allow of a profound intelligence in many of the principles which support them, by the owners of these establishments; which are enriching our city, scattering wealth throughout the neighboring counties, and which would not prosper as they do, did not intelligence and enterprise equally preside over them. But it is a truth that notwithstanding the perfection in art which is already attained, new discoveries are still falling on almost every pinion and wheel, like the drops of a summer's shower to fertilize the earth. The course of improvement is still onwards, and there is no limit to stop its progress. Hence no master workman perhaps knows all the secrets of his own art, and the young mechanic is only entering on the field which he should be taught faithfully to cultivate.

A society, therefore, gentlemen, such as you have formed is highly to be recommended. The advantages of the situation of Pittsburgh never can be obtained till collision of intellect takes place. You are not to be discouraged by failures in some instances formerly. Associations are the great springs of improvement throughout the civilized world. They are in all flourishing cities, and sit far more for the improvement of mankind often than the councils of the burgh or the legislature. And associations for cultivating the science of manufactures, and conducting the spirit of commerce, must succeed, and triumphantly succeed, in a city the site of which, by an eternal decree of providence, was laid out so richly and carefully for these days in which the arts have sprung up so varied and so powerful, and in which they are gathering themselves to the homes and habitations which the arrangements of our globe, by the hand of its maker, had prepared for them.

Our city, like every flourishing seat of manufactures and commerce, is growing into extensive organizations where one mind has the direction of many; and the heads of the establishments should make it a part of their superintendence to keep their workmen, always, if possible, employed on the best

materials, and working according to the most approved patterns. Minds without taste and enterprise of themselves can be trained to a habit of esteem for excellence, and to neatness of workmanship, by seeing nothing but the most excellent materials, and the most predominant beauties in their manufacture. This habit among the hands in kindred establishments, soon, as they occasionally visit one another, generates an honorable rivalry, and the profession becomes a gainer. This was the principle which Bonaparte introduced into the preparation of his exquisite legions; he dressed his officers in the most superb costumes, and his cannon and muskets were the finest and worthiest of their kind. The legions still became better, and had it not been for one false movement in the direction of his splendid machinery, we would not have seen the wheels of it perhaps during his life stopped. The principal heads of the allied establishments should examine the work and patterns in their neighboring workshops, and borrow every improvement which offers itself, and lend also whatever they see may be wanted. It is a mistake, in the present condition of the world, and especially of our country, to think that bringing to the highest degree of perfection, not our individual manufactures, but the manufactures of every other citizen, may prove injurious to our personal interest. What, in our day, promotes the good of the whole, advances that of the primitive genius which corrects abuses, and devises improvements. It will do so especially in our city. The character of our market will rise in the esteem of the extended regions which look to us for their supplies, and customers will be added to customers to enrich the individual, and to spread the rewards of industry over the whole.

But our manufacturers should not only borrow and lend the choicest attainments of their factories and shops, they should cultivate the liveliest intercourse with wholesale merchants and houses of commission: For Pittsburgh has two promising sources of prosperity which lie together, and cannot be sepa-

rated; which reflect profit from hand to hand; and which by intentionally and systematically co-operating can add to the utmost efforts of individual and casual exertion. What I mean is that all our merchants should endeavor to increase the customers of our manufacturers, and our manufacturers should endeavor to promote the business of our merchants. Pittsburgh should have but one interest, and it should be honorably promoted by employing, in intelligent and amiable co-operation, both her arms. Our Board of Trade would lose nothing by adding a little to their name, or should they think that it is most honorable alone, they might divide its superintendence, into the departments of the preparation of goods, and of the commission and sale of them.

The manufacturers should attempt in our growing country, and rapidly increasing city, to give the most suitable education to their apprentices. The present system of education of apprentices is very deficient. They are bound to their master, and he binds himself to give them a knowledge of the business he carries on. What is this knowledge? Of the principles implied in the wares or fabrics he produces? Not at all. The education is graduated on a much lower scale. Principles are in general not considered as to be consulted, but it is intended merely to get the knowledge of the names of things, and to put them up as dictation and custom orders. This is a lame plan of bringing youthful intelligence to preside over that art which it has chosen for a companion for life. It is a Chinese fashion. Old things made after patterns, while the eye never twinkles after an improvement. The tree grows for many ages but there is never the least alteration in its leaves or in its fruit; no graft of amelioration is ever attempted to be put upon it.

To be sure many apprentices are like ancient Vulcan, so lame they never could be taught to walk straight. Masters should espy these, and train them to what they can do. But every extensive shop is an epitome of a nation; while the com-

mon intellect is the most prevalent, there are yet some qualified for all the public walks of life. These should be marked, and educated as well as possible. A quarter or two at a common school to learn, not what is peculiar to their profession, but common to all the concerns of the world, is not what is meant by an education. What is intended is to make a man an intelligent tradesman or mechanic in the business he has chosen. Masters by being attentive themselves to explain principles and to encourage youth to frequent the meetings of a well conducted and intelligent society of mechanics and manufactures, can greatly aid the accomplishment of what we have in view.

To promote the interests of promising youth a society should provide itself with patterns and models of the machinery which is to be used or is to be made. Sketches and drawings attended with the most minute descriptions are very useful in experienced hands, but they are not easily comprehended by young minds, and of themselves excite little curiosity. On the other hand, a model of a machine put under the examination of an enterprising apprentice, who is eager to get acquainted with his business, stays his attention; and permits the eye to walk over every part, examine each separately, and the whole together; it permits a separation of its members for more minute scrutiny; and when it is taken down, it can be put up again by the same hand, and often thus communicates in one day more knowledge to the mechanic than otherwise he could have obtained in many months. He starts on his career, like the celebrated Ferguson, who when a boy following a few sheep, was sent to town on a little errand, and happened to see a clock in the house where he called, and being gratified with permission to examine it, went home and with his knife made all the wheels and pinions of a new one, and picking up two pieces of granite for weights and the neck of a broken bottle for a bell, was highly gratified in making a gift of it to his mother to tell her, like the folk of Aberdeen, how the hours passed.

It seems to me that the policy which lays up all the models that obtain patents is extremely unwise and unenterprising. Instead of heaping them up, like the antiquated armor of the middle ages, in a place where no foot in a manner can tread but that of a transient curiosity, the abundant revenue of our country should keep a qualified person to prepare patterns of every model and of every improvement, and to transmit these to the principal kindred manufacturing establishments throughout the country. This would keep alive that curiosity which stimulates to the acquisition of knowledge, by presenting to inspection the effects of recent ingenuity, by shewing them under forms easily comprehended, and by suggesting to every mind of any capacity, some of those analogies on which a new improvement could be engrafted. All improvements that are made, except merely fortuitously, arise by the perception of the analogies that are among things; and the thousand minds which throughout the country would be thus set to work would accumulate improvements; which would again suggest new analogies as fruitful sources of still further progress throughout the land.

It appears almost certain that a remuneration from government for a new machine or an improvement on an old one, would be as great an excitement as the profits of a patent; and that it would be a wise measure of legislation to annul the patent law, so fruitful of disputes and litigation, and to throw the whole improvements of the nation before the public; to gather them up, and apply to the fundamental interests of society. The practice of bestowing patents seems to be a remnant of that feudal policy which granted titles of knighthood to fortunate bravery, and privileges to citizens of a town, under the name of burghers—planting the rights of trades, manufactures and commerce, in particular families, to the exclusion of all the rest. In a young, growing, industrious and aspiring population like ours, intellect should be elicited, enticed, cherished and gratified, by the whole forms of mental conception that

have been impressed on matter being delivered into the bosom of their enterprising ingenuity. What arises from the depths of the human mind in all arts and sciences should be like the vapor which arises from the ocean; it is carried buoyant and free on the wings of the wind, and spreads itself in summer showers over all lands to fertilize them.

The first thing to promote the interests of your society will be to avoid discussions and lectures on subjects not particularly interesting to the members of the society. The exhibition of knowledge on scientifical subjects which are not connected with the daily pursuits of practical men, is attended with two circumstances which weary attention, induce langor, and make punctual attendance irksome and disagreeable. These two things are, the foreign nature of the subject to what usually interests their minds, and the unintelligible nature of many of the technical terms which constitute the language of the particular science, and to become acquainted with which is more than what can reasonably be expected from them. Should botany, or anatomy, or even mineralogy in the most extensive sense of the term, be chosen, the subjects though highly pleasing in themselves, would lead to weariness if prosecuted beyond the very first elements, by the little interest which would be felt in them, and by the very terms which are the language of the science. Even chemistry, unless treated in a very popular manner, and by one equally expert in experiments and fluent in diction, cannot keep life in a society of varied mechanics. The poisonous wind which frightens members from attendance in a society they have been eager to form, is the absurdity of adopting some science admired in the schools, but not interwoven with the pursuits of the members, and putting this science into the management of some person unaccustomed to public teaching and extemporary explication. The more eager the members of the society were to form it, and the more intelligence they had in their own practical departments, the sooner they become disgusted; and they forsake the room

where they anticipated a rich repast but where they see nothing but clumsy servants and empty dishes.

The man who is to bind together and encourage a society constituted for the objects you contemplate, should be a man of very general science; and one who, by the fascinations of his expression, can win attention. In arithmetic he should be an adept to point out how distinctly proportions can be stated, how easily relations can be ascertained by the raising of powers, and the extraction of roots; and how correctly fellowships can be settled, or mixtures of any kind compounded. Geometry should be so familiar to him that its principles, as applicable to the arts, should never be to be sought for; but as soon as the subject is suggested, the lines which enclose it from the principles demonstrated in Euclid, should come under his power of expression. He should be a master in algebra; not merely to teach some of its elements, but principally to explain to the uneducated the formulæ, with which our best treatises on mechanical subjects abound. Formulæ are modes of setting down the principles of a science, or the foundations of any art, in general algebraical symbols; and are infinitely the shortest and best method of treasuring up knowledge on such subjects; but it is lost to those who cannot read the artificial language in which they lie contained. The celebrated writers on the continent of Europe give to the world almost all their knowledge of mechanical science in expressive formulæ. Coulomb has the richest treasures under this covering; and La Grange, La Place, Monge, and other celebrated writers sum up all the results of their investigations in the most symmetrical expressions of algebra, and the differential and integral calculus. La Place in his mechanism of the heavens has little of original discovery; but he has followed up the principle of gravitation with great minuteness in the movements of the moon, on the tides, and on every branch of physical astronomy, and has given all his results in formulæ of permanent beauty and of easy interpretation. As has been said of him, he has laid up for all ages to come, and for people of all languages, (for formulæ

belong to universal language,) the richest collection of perfectly finished and imperishable wares the world ever received. Formulae bear near the same relation to ordinary language that a painting does to a description; or that a perfect model does to a drawn plan: and to one who understands the secret of the symbols, there is nothing that strikes light so fully and so unerringly into the mind. Your teacher, as these under a few symbols put on an immensity of forms, should not only be one of the initiated, but an adept in the comprehension of the mysteries.

He should also be well acquainted with the principles of natural philosophy. This comprehends the elements of all machines; and its professed object is to demonstrate the principles of their construction, to describe the manner of their formation, and to ascertain the laws of their motion. Natural philosophy is the most ancient and the noblest branch of practical science. It describes the universal properties of matter, and brings to light gravitation, without which nothing on earth could find a permanent habitation, nor could any kind of power whatever be employed to propel machinery. We are disposed whenever we hear the word gravitation, to think of the movements of the heavenly bodies, or of the fall of bodies towards the earth; but in the application of water or steam to turn machinery, the agency of this principle does not so naturally occur to us. But as action and re-action are equal, no wheel could be turned but would be carried along in the line of the force, and by the slightest impulses, were it not for the statical principle of gravity. Natural philosophy calculates direct force, and the amount of force applied in any angle of obliquity. It fixes the relations between uniform and accelerative motion; and it takes up every form of curve, and comparing it with the circle which is generated by the velocity acquired in falling through half of the radius, it tells what exact variation of power is necessary to generate any other given instance of curvature. It gives the properties of the simple mechanical powers, and the principles of equilibrium; and it

adjusts the effects of the collision of bodies in the degree of their spring or elasticity. It calculates the pressure of all fluids, and the specific gravities of all bodies; it follows up by exact laws their undulations; and explains waves and the tides of the ocean; it brings under the power of numbers the momentum of every stream, and the power of every head of water; it tells us that on the principle of Bramah's press a pint of water may be made to raise many tons, and shows us that many of the mountains of our earth have suffered a disruption of their fundamental strata, by a small column of water which, at the depth of many hundred feet, found a solid base, and accumulating burst laterally the solid adamant of the mountain. It takes into its hand the treatment of air and steam, and calculates their powers and uses; it explains all the fundamental laws of sound and music, it traces the path of every projectile, and teaches how far a given force will cast it, and what deviations atmospherical resistance produces; and it constructs and describes all the different kinds of machines which water, air, or steam impels.

It takes up heat, light, electricity, and magnetism, and calculates the relations between the degree of heat, and the elasticity of the steam it generates; it investigates all the laws of optics, and points out the exquisite pleasures and utilities of that science; it shows us that electricity while it is a ruling agent throughout the economy of nature in all her changes, is in the thunder no less beneficent than grand; for though it assumes no direct influence over vegetation, yet it pours from the clouds in a few minutes more rain than otherwise days could give us; and having bathed the bosom of our fields, it passes off to let the sun visit and warm them; and it delineates a chart of the magnetism on the surface of our globes, and tells how at this point and the other of the earth, the mariner's compass must stand. It, in a word, explains the laws and mechanism of our solar system, placing in admirable precision before us the density, the time of rotation, the

distance, the light and the heat which belongs to every planet; and steps off to the fixed stars, and calculates to us, that while light comes from the sun in eight minutes and twelve seconds, it could not travel from the fixed stars in less than three years and a half.

Some think that chemistry can stand a competition with natural or mechanical philosophy. Chemistry is a useful science, and its operations are found throughout the kingdom of nature and of art. It is, however, as much inferior to natural philosophy as a block of marble is to the Belvidere Apollo, or to the Venus De Medici. Chemistry and natural philosophy stand compared as the colors of a painting to the admirable lineaments which Anacreon ascribed to his picture of beauty, when, in exstacy, he stopped the hand of the limner, and exclaimed, it is about to speak. Chemistry is a culinary hand-maid, natural philosophy is a mechanic which builds palaces. Chemistry rears the vegetation on the earth's surface, mechanical science gives the earth its form and carries it in its mighty orbit. Chemistry attempts to lead us into the intimate nature of things, and often expresses herself in a faltering voice; natural philosophy treads through all the varied movements of every machine in the universe, and is scarcely ever inclined to hesitate. The two often amiably co-operate. The one prepares the sap of vegetation, and the other gives the form to the stem, the blossom and the fruit. Mechanical science laid out the admirable structure of the arteries and veins of living creatures, and chemistry serves the elements for the blood which by these channels continually circulate to support them. Both are matter. This is inert. Mind is the cause; and from this fact alone, that mind only can contrive either the whole universe, or one of our little machines, like a watch or a clock, it follows that natural philosophy as far exceeds chemistry as the mechanic exceeds his materials.

Some ascribe to chemistry what does not at all belong to it. The dignified part of a chemist's apparatus belongs to mechanical philosophy, and they are some acids, or metals, or airs

that are his own elements. With these he can indeed work wonders. He can change all colors, reduce the rocks of the earth into invisible agents, destroy every trace of organization in all that has been possessed of life; while his processes are accompanied with a brilliancy and beauty which are greatly to be admired. When the chemist prepares himself to burn gold and diamonds, when he puts on strength to separate water into its original elements, or to reduce the flint stone into an air and a metal, when he proceeds to show us the various products of his laboratory, his acids which he has procured, his salts which he has formed, his earths which he has separated from all admixtures, the agents and re-agents which out of all the mineral, the vegetable, and the animal kingdom he hath obtained for himself, we cannot but acknowledge that the genius which comprehends the facts of chemistry, and adds by enterprise to their amount, might, like Sir Humphrey Davy, be placed at the head of the philosophical society, and become a kind of rival of Sir Isaac Newton. Yet how inferior is he! He is great, Sir Isaac is unrivalled. He astonishes by the ingenuity, brilliancy, and success of his experiments, Sir Isaac amazes by the extent of capacity and intellectual comprehension which the bringing to light and settling the laws of the universe, bespeak. We see the standing of the chemist and of the natural philosopher, in a single attempt of these two great men. Sir Humphrey prepares his immense voltaic battery, and puts a little diluted potash under its agency—an air ascends from the one wire, and a dark glistening substance of metallic lustre is at the extremity of the other. The question is settled,—potash is a compound! Sir Isaac looks not at a fabric made by men; the moon is carried round our earth, can the principle of gravitation account for her movements? Her path is full of irregularities. His mind grasps the general outline of the whole plan, and sitting down to cast up her accordancies with his conceptions, the success before him overawes him and makes him tremble under the grandeur and consequences of this one step of true philosophy.

I have made these observations to place chemistry, an attractive science by the superficial nature of its doctrines, and the attractions of its experiments, in its true comparative light before the members of this Institute; and to recommend, in this mechanical city of ours, as much as possible, the study of the sterner and more veteran science of natural philosophy. She is indeed like many, that have grown rich and great with the spoils of time, to be approached through the services of others; arithmetic, geometry, algebra, and the higher calculus; but a small portion of some of these are in all departments highly useful, and sometimes a familiarity with her general principles dwells advantageously among a people whose abode is laid out by nature as the habitation of the mechanic arts.

I am aware that it may be said that we have far more people who love chemistry than natural philosophy. So we have; and we have more people regardless of both sciences, than we have acquainted with either of them. Every man almost courts as much ease as he can, and every student almost dislikes difficult tasks. This is the reason; but such unenterprising individuals forget that all Grecian and Roman antiquity believed that Pythagoras, by extent of comprehension and restless application, discovered the theorem which the Brahmins, from whom he borrowed it, called the bride, and they praised him for offering a whole hecatomb out of gratitude for his success. Determined application has her foot as frequently among thorns as on the beaten path; but when she has passed safely through, her heart is swelled with the remembrances of that success alone which attended her where her hardships lay. The great Kepler labored with unwearied care in a theory which he was forming of the heavens; and combined many analogies, and calculated the promises of their amount; but after a period of twenty years the absurdities of his plan opened so thickly upon him, he abandoned it in despair; but his perseverance turned him to a more promising subject, and he has left to the world those rich legacies in mechanical science which will live while letters and civilization continue among men.

Glass is one of our earliest manufactures. There is chemistry in the application of heat and the melting of the silex and alkali; but the blowing of the glass, the moulding, and cutting are purely mechanical processes. Here, however, I grant genius plays her part most conspicuously in the preparation of the materials. Our silicious sand is seldom perfectly pure, and the foreign ingredients are apt to injure the color and translucency of the glass. It is overcome, in most of our establishments of flint glass; and the window glass, which, to be in the utmost perfection of its kind, requires equal chemical knowledge, and more mechanical skill to prevent waves, is rapidly improving. Considering our advantages, and the permanency and extent of the demand which is to be made upon us in this article, our manufacturers should be ambitious to attain in color, in temper, and in uniformity of substance, the highest excellence.

Iron is our most abundant manufacture. The ores require skill to produce from them the best metal. The chemist's experiments may be useful in essaying the different kinds of ore, and they have yet much to do before throughout the world there shall be no further call for them. The metals are primitive simple substances, and when procured alone they are always of the same excellence. They are not like diamonds or precious stones, of different waters, and different degrees of purity. Gold is the same in every spot of our earth. So is every other metal when absolutely unalloyed. In simple substances, or chemical binary or tertiary compounds, there is no variety. The water we drink is, when unmixed, the same in excellence every where. So is the air we breathe. Hence could we obtain iron absolutely free from foreign admixtures, or with the same elements always in it, we would not have different names of inferior and superior, but all would be equally excellent. This fact brings to view a most extensive field for experiments; not on ores only, but on the management of every part of the processes by which the iron is prepared. It seems the belief of many, that the difference in the qualities

of iron is in its own nature. It is a contradiction to its simplicity as a metal. The differences arise from the different proportions of oxygen and carbon that in the smelting has combined, or from some foreign ingredient in the alumine or silex, or earth belonging to the ore, and which cannot be dispelled by the processes in use. When chemistry considered the union of the elements of things fortuitous, no exertion was expected to be made to obtain iron equally good from whatever matrix it might be taken; but since within these few years the doctrine of definite proportions has effected such a complete revolution in men's views, science should carry her enterprize into those vast establishments from which a brood of manufactures springs like the gradations of living distances. In a summer's day every place is full of insects, their species vary, and the natures of some of them approach a higher genus; these border upon others above them, and while the individuals become fewer, the kind is greatly exalted; until we come to the lion and elephant who live in secluded and solitary habitations. So, iron bending in the cotton card or formed into the head of a pin, varies, and increases into every instrument which man can handle, until it shows itself in the pillars of buildings, in bridges of the most ponderous workmanship, in roads over the earth's surface, and in ships sailing the mighty ocean. The world of old said that Vulcan made Jupiter's thunder bolts; we reject the fable, and yet we can give something bearing a little resemblance to it—it is the agency of fire connected with iron, that almost with the power and rapidity of lightning turns our machinery, sends us to distant places, and makes voyages with that speed for which the ancients could no more account than they did for the origin of the fires of Etna, Vulcan's workshop.

The manufacture of cotton is a new habit which within these few years has sat down among men. It has produced the most astonishing changes. The manufacture of no other article has increased with such amazing rapidity. Its fabrics are in many instances of the finest texture. The whole ma-

chinery connected with it, in growing, carding, spinning, weaving, bleaching, is in a continual state of improvement. The great object in a cotton manufactory is a perfect knowledge of the character of the machinery and of the best manner of working it. Often an owner would be a gainer to cast off his present machinery and purchase the whole new, with the improvements which the best specimens possess. We state this, because in the condition of the world, the manufacture of this material must continue to be as permanent as the wants of mankind; and while its increase is so amazing, emulation, on such an extensive scale, must soon leave a stationary establishment far behind, with both the loss of reputation and of custom. The eye of the master here should be directed to command uniformity of power, to see that this does not run to waste by the laboring of the more weighty parts of his machinery, and every wheel and pinion should be minutely examined to see that a minimum of resistance is attained throughout the whole of the works.

The perfection of machinery, continued skillful exertion, and advantages of natural location, can alone preserve a profitable market to any particular manufactures. In the days of ancient Greece patriotism was bounded by territories of a few miles square, and except when an external power terrified her States into a union of exertion they looked upon each other like wild beasts of different species; but civilization has already brought mankind into one great family, and as it spreads, it interweaves more closely the mutual interests of all; so that intelligence and industry will continue to be the mistresses who will bestow the palm on the most deserving. It might indeed be supposed that national legislation could control this tendency to a republicanism in the manufactures, trade, and commerce of the civilized nations of the earth. This is a mistake. It might disjoint a few wheels in the machinery of society, but as nature always shows tendencies to correct and remedy any hurt which is given to any of her members, so the native vigor and appetencies of the manufacturing republic of

mankind, will, in process of time reduce the most violent and powerful instances of dislocation. Human laws are good and irresistible in all instances except where they encounter nature, and would control the birth and fruit of liberty and civilization among men.

Patriotism is now of necessity a wave which is daily widening its circle, and is melting into that unlimited affection which is the birth of reason and the parent of universal good. Governments must be supported, the wisest being the least expensive; and the ports of the respective nations of the earth will contribute to the national demands; but they will look upon themselves as the heart of the prosperity of mankind, and receive with dissatisfaction any order, even for a short time, at variance with those measures which, however intended by individuals, philosophy says are to civilize and clothe with our science, our arts, our manufacturing powers, our social habits, and all our features of highly enlightened men, the families, the tribes, and the nations of mankind;—that they may supply one another's exigencies, and grow richer, in every part, by the active industry of all. This view of things seems to anticipate that period to which so many other indications are pointing, when mankind will consider themselves as brethren, and will no more waste the lives, and destroy the fruits of each others labor; but all people brought into near neighborhood by the improvements in navigation, and the eagle flight of land conveyance, will appear with the arteries and veins of a perfect system running through every member, and bestowing life, support, and happiness upon the whole. Hence I conclude in the celebrated words of Virgil, which may be thus translated: "The fates, with one heart, by an immutable decree, have said, run such ages, ye offspring of Deity; the great improvements come from Jupiter; enter upon the mighty honors; see the world changing from pole to pole; the land, the paths of the sea, the sky itself: behold, how all things shall be gladdened in the age that is to come."

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